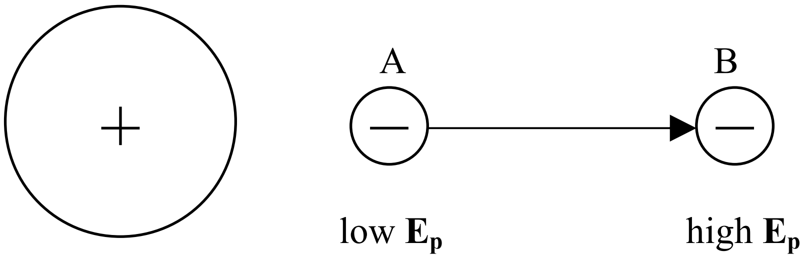
A Review of Circuitry

There is an attractive force between a positive and a negative charge. In order to separate these charges, a force *at least* equal to the attractive force must be applied to one of them:



Work = Fd $\quad\quad$ $\mathbf{W = \Delta E_p}$

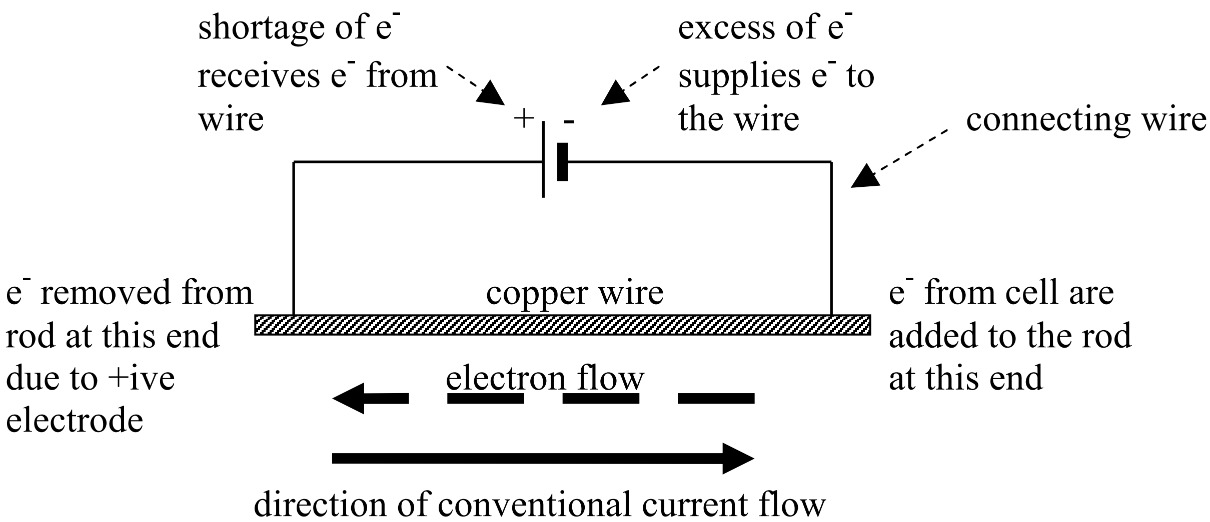
This force, acting over a distance, does work *on* the charge that is moved, so the charge receives potential energy. Such work can be done by chemical reactions taking place in a battery or dry cell, or by mechanical forces in a generator.

If the negative charge is subsequently released at **B**, it will move back to position **A**, *releasing* energy which is equal to the original work done to move the charge to **B**.

Now consider the inside of a dry cell:

- When charge is separated between the two electrodes through chemical reactions, an <u>electric field</u> is created between the different charges and the differently charged electrodes. In particular, the electrons that have accumulated at the negative electrode have gained potential energy.
- If a conducting wire then connects these two electrodes, another electric field is set up in the wire, causing a force to be exerted on every movable charge in the wire, creating electron flow. Electrons now move back through the wire from the negative electrode, or *terminal*, of the battery to its positive terminal, losing potential energy along the way.

A summary of this process is shown in the following diagram.



Note that as the charge moves back through a wire, energy is given off to heaters, light bulbs, motors, buzzers or any other circuit elements that can absorb energy.

Pay close attention to the direction arrows:

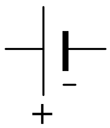
- *Electron flow* refers to the flow of negative charges, repelled from the negative terminal of a chemical cell and attracted to the positive terminal.
- *Conventional current* refers to the direction that an imaginary positive test charge would take if placed into the conductor (the same direction as the field **E** set up in the wire by the potential difference). This convention was first adopted by scientists in the 1800's, before there was a clear understanding of the sub-atomic structure of the atom.

For current flow to occur, an electric *circuit* must be set up. All circuits require the following:

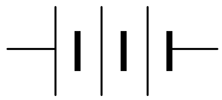
- a *power supply* to give the electrons potential energy.
- a *conductor*, which is a material that allows a free-flow of electrons with little resistance). The most common conductors include:
    - metal conductors (e.g., copper, gold, aluminum).
    - ionized gases or liquids (e.g., electrolytic solutions like salt water).
    - A gas discharge tube (such as a CRT that produces an electron beam).
- a *resistor* to use the energy. A resistor is a material that resists electron flow and converts electrical energy to some other form of energy. Examples of resistors include motors, heaters, light bulbs, etc.

The various ways in which electricity can travel from a source throughout a circuit can be represented by a schematic diagram. Common circuit symbols include the following:

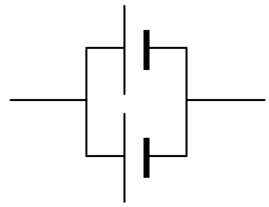
cell



cells in series

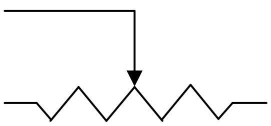


cells in parallel

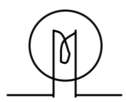


resistor

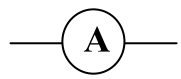
variable resistor



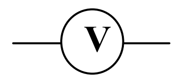
lamp



ammeter

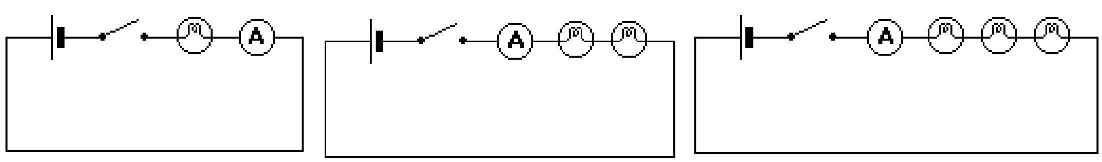


voltmeter



Two types of circuits you should be familiar with are as follows:

- *Series Circuit* - A single current path for electron flow; e.g.:



- *Parallel Circuit* - more than one current path for electron flow to occur; e.g.: